

The same side of the moon always faces Earth.



FIGURE 10

The Moon in Motion


The moon rotates on its axis and revolves around Earth in the same amount of time. As a result, the near side of the moon (shown with a flag) always faces Earth.

Interpreting Diagrams Would Earth ever appear to set below the horizon for someone standing next to the flag on the moon? Explain.

Phases of the Moon

On a clear night when the moon is full, the bright moonlight can keep you awake. But the moon does not produce the light you see. Instead, it reflects light from the sun. Imagine taking a flashlight into a dark room. If you were to shine the flashlight on a chair, you would see the chair because the light from your flashlight would bounce, or reflect, off the chair. In the same way that the chair wouldn't shine by itself, the moon doesn't give off light by itself. You can see the moon because it reflects the light of the sun.

When you see the moon in the sky, sometimes it appears round. Other times you see only a thin sliver, or crescent. The different shapes of the moon you see from Earth are called **phases**. The moon goes through its whole set of phases each time it makes a complete revolution around Earth.

Phases are caused by changes in the relative positions of the moon, Earth, and the sun. Because the sun lights the moon, half the moon is almost always in sunlight. However, since the moon revolves around Earth, you see the moon from different angles. The half of the moon that faces Earth is not always the half that is sunlit.  **The phase of the moon you see depends on how much of the sunlit side of the moon faces Earth.**

The Moon Seen From the Northern Hemisphere



1 New Moon
The sunlit side faces away from Earth.



2 Waxing Crescent
The portion of the moon you can see is waxing, or growing, into a crescent shape.



3 First Quarter
You can see half of the sunlit side of the moon.



4 Waxing Gibbous
The moon continues to wax. The visible shape of the moon is called gibbous.

FIGURE 11

Phases of the Moon

The photos at the top of the page show how the phases of the moon appear when you look up at the moon from Earth's surface. The circular diagram at the right shows how the Earth and moon would appear to an observer in space as the moon revolves around Earth.

Interpreting Diagrams During what phases are the moon, Earth, and sun aligned in a straight line?

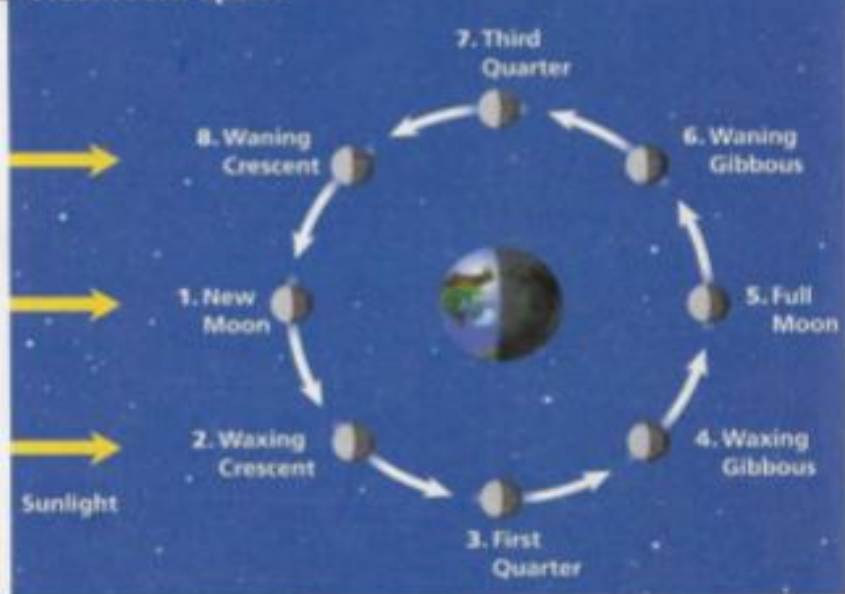
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View From Space





5 Full Moon
The entire sunlit side faces Earth.



6 Waning Gibbous
The portion of the moon you can see wanes, or shrinks.



7 Third Quarter
You can see half of the moon's lighted side.



8 Waning Crescent
You see a crescent once again.



To understand the phases of the moon, study Figure 11. During the new moon, the lit side of the moon faces completely away from Earth. As the moon revolves around Earth, you see more and more of the lighted side of the moon every day, until the side of the moon you see is fully lit. As the moon continues in its orbit, you see less and less of the lighted side. About 29.5 days after the last new moon, the cycle is complete, and a new moon occurs again.



Reading Checkpoint What is a new moon?

Eclipses

As Figure 12 shows, the moon's orbit around Earth is slightly tilted with respect to Earth's orbit around the sun. As a result, in most months the moon revolves around Earth without moving into Earth's shadow or the moon's shadow hitting Earth.


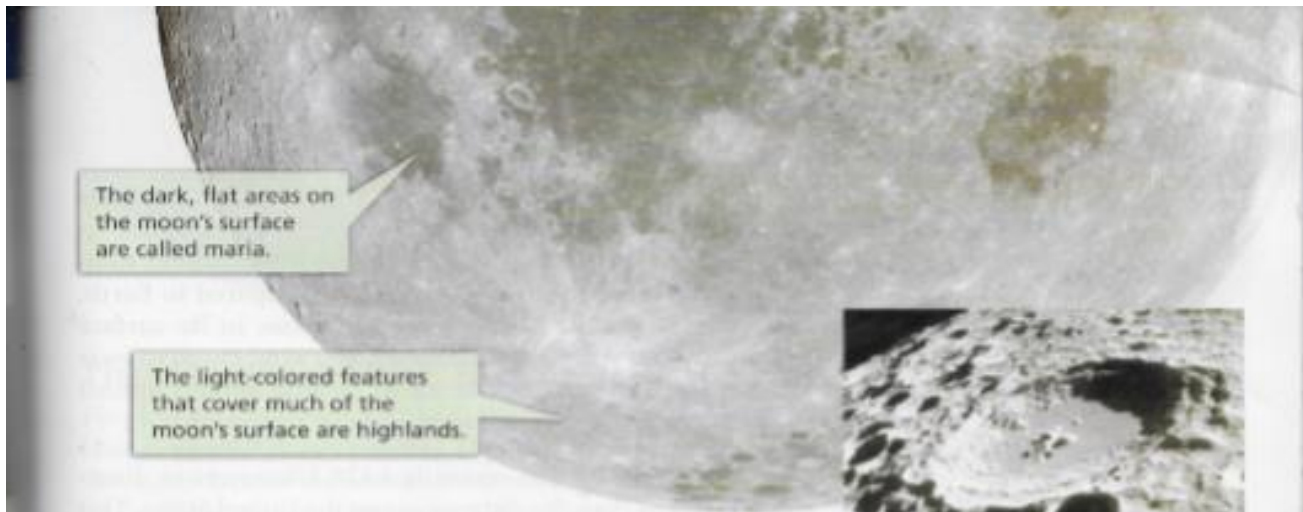
 **When the moon's shadow hits Earth or Earth's shadow hits the moon, an eclipse occurs.** When an object in space comes between the sun and a third object, it casts a shadow on that object, causing an **eclipse** (ih KLIPS) to take place. There are two types of eclipses: solar eclipses and lunar eclipses. (The words *solar* and *lunar* come from the Latin words for "sun" and "moon.")

FIGURE 12

The Moon's Orbit

The moon's orbit is tilted about 5 degrees relative to Earth's orbit around the sun.






The dark, flat areas on the moon's surface are called maria.

The light-colored features that cover much of the moon's surface are highlands.

The Moon's Surface

Recent photos of the moon show much more detail than Galileo could see with his telescope.  Features on the moon's surface include maria, craters, and highlands.

Maria The moon's surface has dark, flat areas, which Galileo called **maria** (MAH ree uh), the Latin word for "seas." Galileo incorrectly thought that the maria were oceans. The maria are actually hardened rock formed from huge lava flows that occurred between 3 and 4 billion years ago.

Craters Galileo saw that the moon's surface is marked by large round pits called **craters**. Some craters are hundreds of kilometers across. For a long time, many scientists mistakenly thought that these craters had been made by volcanoes. Scientists now know that these craters were caused by the impacts of **meteoroids**, chunks of rock or dust from space.

The maria have few craters compared to surrounding areas. This means that most of the moon's craters formed from impacts early in its history, before the maria formed. On Earth, such ancient craters have disappeared. They were worn away over time by water, wind, and other forces. But since the moon has no liquid water or atmosphere, its surface has changed little for billions of years.

Highlands Galileo correctly inferred that some of the light-colored features he saw on the moon's surface were highlands, or mountains. The peaks of the lunar highlands and the rims of the craters cast dark shadows, which Galileo could see. The rugged lunar highlands cover much of the moon's surface.



Reading
Checkpoint

What are meteoroids?



FIGURE 18

The Moon's Surface

The moon's surface is covered by craters, maria, and highlands. Craters on the moon formed from the impact of meteoroids. Most large craters are named after famous scientists or philosophers.

Observing What are the light regions in the top photograph called?



For links on Earth's moon
Visit: www.SciLinks.org
Web Code: scn-0614



FIGURE 19

The Moon's Size

The diameter of the moon is a little less than the distance across the contiguous United States.

Calculating What is the ratio of the moon's diameter to the distance between Earth and the moon?

Characteristics of the Moon

Would you want to take a vacation on the moon? At an average distance of about 384,000 kilometers (about 30 times Earth's diameter), the moon is Earth's closest neighbor in space. Despite its proximity, the moon is very different from Earth. 🌕 **The moon is dry and airless. Compared to Earth, the moon is small and has large variations in its surface temperature.** If you visited the moon, you would need to wear a bulky space suit to provide air to breathe, protect against sunburn, and to keep you at a comfortable temperature.

Size and Density The moon is 3,476 kilometers in diameter, a little less than the distance across the United States. This is about one-fourth Earth's diameter. However, the moon has only one-eightieth as much mass as Earth. Though Earth has a very dense core, its outer layers are less dense. The moon's average density is similar to the density of Earth's outer layers.

Temperature and Atmosphere On the moon's surface, temperatures range from a torrid 130°C in direct sunlight to a frigid -180°C at night. Temperatures on the moon vary so much because it has no atmosphere. The moon's surface gravity is so weak that gases can easily escape into space.

Water The moon has no liquid water. However, there is evidence that there may be large patches of ice near the moon's poles. Some areas are shielded from sunlight by crater walls. Temperatures in these regions are so low that ice there would remain frozen. If a colony were built on the moon in the future, any such water would be very valuable. It would be very expensive to transport large amounts of water to the moon from Earth.



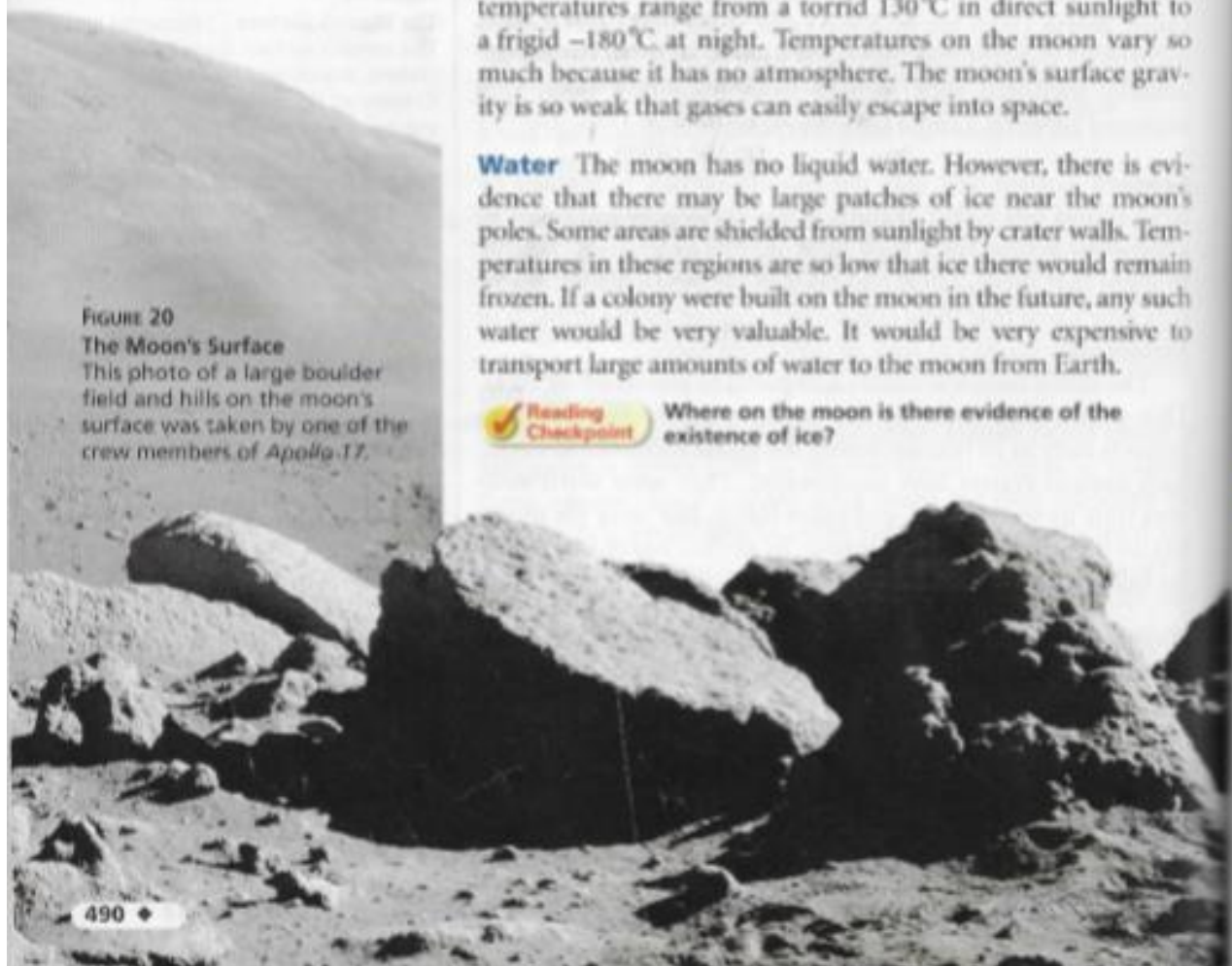
Reading Checkpoint

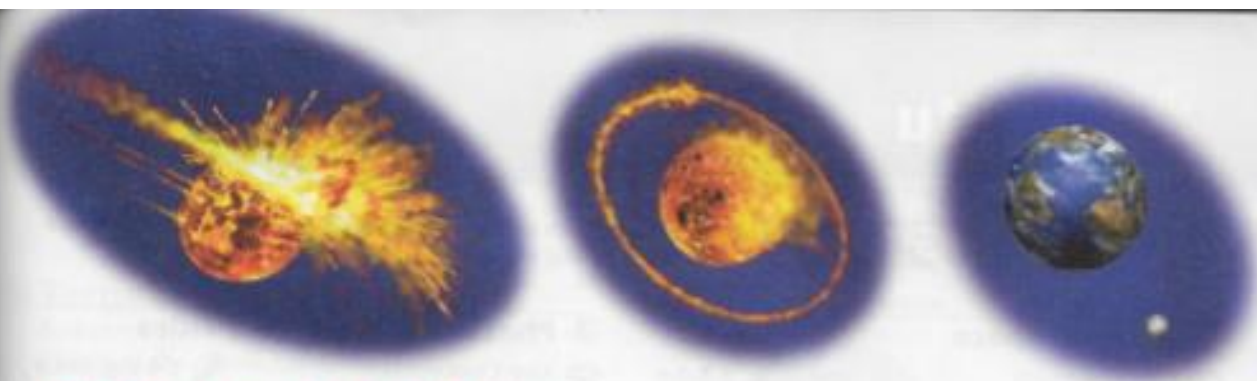
Where on the moon is there evidence of the existence of ice?

FIGURE 20

The Moon's Surface

This photo of a large boulder field and hills on the moon's surface was taken by one of the crew members of Apollo 17.





The Origin of the Moon

People have long wondered how the moon formed. Scientists have suggested many possible hypotheses. For example, was the moon formed elsewhere in the solar system and captured by Earth's gravity as it came near? Was the moon formed near Earth at the same time that Earth formed? Scientists have found reasons to reject these ideas.

The theory of the moon's origin that seems to best fit the evidence is called the collision-ring theory. It is illustrated in Figure 21. About 4.5 billion years ago, when Earth was very young, the solar system was full of rocky debris. Some of this debris was the size of small planets. **Scientists theorize that a planet-sized object collided with Earth to form the moon.** Material from the object and Earth's outer layers was ejected into orbit around Earth, where it formed a ring. Gravity caused this material to combine to form the moon.

FIGURE 21

Formation of the Moon
According to the collision-ring theory, the moon formed early in Earth's history when a planet-sized object struck Earth. The resulting debris formed the moon.

Video Field Trip
Discovery Channel School
Earth, Moon, and Sun

Section 4 Assessment

S.8.4.e, E-LA: Reading 8.1.2

Vocabulary Skill Latin Word Origins What are maria? Why did Galileo select the word *maria* for this feature of the moon? Does the Latin origin of this word accurately describe what scientists today know about the moon? Why or why not?

Reviewing Key Concepts

- Identifying** Name three major features of the moon's surface.
 - Explaining** How did the moon's craters form?
 - Relating Cause and Effect** Why is the moon's surface much more heavily cratered than Earth's surface?
- Describing** Describe the range of temperatures on the moon.
 - Comparing and Contrasting** Compare Earth and the moon in terms of size and surface gravity.

- Relating Cause and Effect** What is the relationship between the moon's surface gravity, lack of an atmosphere, and temperature range?
- Identifying** What theory best describes the moon's origin?
 - Describing** What was the solar system like when the moon formed?
 - Sequencing** Explain the various stages in the formation of the moon.

Lab
zone

At-Home Activity

Moonwatching With an adult, observe the moon a few days after the first-quarter phase. Make a sketch of the features you see. Label the maria, craters, and highlands.